REMARKS/ARGUMENTS

Favorable reconsideration of this application as presently amended and in light of the following discussion is respectfully requested.

Claims 1-4, 17-35, and 56-65 are pending in the present application. Claims 5-16 and 36-55 are canceled without prejudice, Claims 1-4, 18-22, and 30-34 are amended, and Claims 56-65 are added by the present amendment.

In the outstanding Office Action, the specification was objected to; the drawings were objected to; Claims 11, 33, and 34 were objected to; Claims 1-11, 17, 18, and 36 were rejected under 35 U.S.C. § 102(b) as anticipated by Molotov et al. (JETP Lett., vol. 63, no. 8, pages 687-693, "QUANTUM CRYPTOGRAPHY BASED ON QUANTUM DOTS," herein "Molotov"); Claims 12-14 were rejected under 35 U.S.C. § 103(a) as unpatentable over Molotov in view of Frazier et al. (U.S. Patent No. 5,646,418, herein "Frazier"); Claim 15 was rejected under 35 U.S.C. § 103(a) as unpatentable over Molotov in view of Fafard et al. (U.S. Patent No. 6,239,449, herein "Fafard"); Claims 19, 21, 30, and 32-34 were rejected under 35 U.S.C. § 103(a) as unpatentable over Molotov in view of Crow (U.S. Patent No. 5,423,798); Claims 20 and 22-27 were rejected under 35 U.S.C. § 103(a) as unpatentable over Molotov in view of Sugiyama (U.S. Patent No. 6,177,684); Claims 28 and 29 were rejected under 35 U.S.C. § 103(a) as unpatentable over Molotov in view of Sugiyama and Cho et al. (U.S. Patent No. 5,314,838, herein "Cho"); and Claim 31 was rejected under 35 U.S.C. § 103(a) as unpatentable over Molotov in view of Sugiyama and Crow.

Regarding the objection to the specification, the specification has been amended as suggested in the outstanding Office Action without adding new subject matter. Accordingly, it is respectfully requested this objection be withdrawn.

Regarding the objection to the drawings, formal drawings including corrections as suggested in the outstanding Office Action are filed with this response. No new matter has been added. Accordingly, it is respectfully requested this objection be withdrawn.

Regarding the objection to Claims 11, 31, and 34, Claim 11 has been cancelled and Claims 31 and 34 have been amended as suggested in the outstanding Office Action without adding new matter. Accordingly, it is respectfully requested this objection be withdrawn.

Claims 1-11, 17, 18, and 36 were rejected under 35 U.S.C. § 102(b) as anticipated by Molotov. That rejection is respectfully traversed.

Independent Claim 1 has been amended to recite that supply means are "electrical supply means for supplying carriers to the energy levels." The claim amendment finds supports in the specification, for example at page 8, last paragraph. No new matter is believed to be added.

Briefly recapitulating, amended independent Claim 1 is directed to a photon source that allows emission of a predetermined number of photons at predetermined times. The photon source includes a quantum dot and electrical supply means. The quantum dot has a first confined energy level capable of being populated with a first carrier, which is an electron, and a second confined energy level capable of being populated by a second carrier, which is a hole. The electrical supply means electrically supply carriers to at least one of the energy levels to allow recombination of carriers in the quantum dot to emit at least one photon.

As discussed in the previously filed response, both Figures 2 and 17 show the claimed photon source. More specifically, in a non-limiting example, Figure 17 shows the quantum

dot layer 109, and the electrical supply means including a doped barrier layer 113 that supplies holes, and an injection layer 105 that supplies electrons.[1]

Turning to the applied art, Molotov shows in Figure 1a and discloses at page 688 an optical supply unit (circular polarized photon), and the outstanding Office Action asserts at page 3, last paragraph, that the optical supply unit corresponds to the claimed electrical supply means. However, the supply unit in Molotov is an ***optical*** supply unit and not ***electrical*** supply means as required in amended Claim 1. In addition, Molotov is silent about populating energy levels in the quantum dot with electrons by using an electrical signal as opposed to an optical signal.

Further, Applicants respectfully submit that an electrically injected photon source is not obvious in light of Molotov because Molotov provides little details about the structure of the device, and one of ordinary skill in the art would not configure an optical supplied source as an electrically injected structure. Furthermore, in an electrically injected structure, carriers may also be injected into a semiconductor between quantum dots and strong emission would occur in that region. This problem of the background art is solved by the claimed device. In addition, when considering a photon source, it is necessary to maintain good output surfaces, i.e., surfaces not covered by electrodes. Therefore, it is not obvious for one of ordinary skill in the art to take an optically activated device and configure it as an electrically activated device without covering output surfaces with electrodes.

Accordingly, it is respectfully submitted that independent Claim 1 and each of the claims depending therefrom patentably distinguish over Molotov.

[1] Specification, page 35, last paragraph.

Claims 12-14 were rejected under 35 U.S.C. § 103(a) as unpatentable over Molotov in view of Frazier. That rejection is moot because Claims 12-14 have been canceled. However, the device of Frazier is discussed next in view of Claim 1.

Frazier discloses at column 2, lines 15-20, a three terminal switching device having electrical contacts. However, the device of Frazier does not have a photon source as recited in independent Claim 1. Further, Frazier does not teach or suggest using the electrodes to input carriers into a quantum dot. Because an optical device in Molotov differs from a transport device in Frazier, an optical device necessary extracts light from the structure and the transport device does not extract light, Applicants respectfully submit that there is no motivation or suggestion to combine the device of Molotov with the device of Frazier. Thus, it is respectfully submitted that Claim 1 and each of the claims depending therefrom patentably distinguish over the combination of Molotov and Frazier.

Claim 15 was rejected under 35 U.S.C. § 103(a) as unpatentable over Molotov in view of Fafard. That rejection is moot because Claim 15 has been cancelled.

Claims 19, 21, 30, and 32-34 were rejected under 35 U.S.C. § 103(a) as unpatentable over Molotov in view of Crow. That rejection is respectfully traversed.

The outstanding Office Action relies on Crow for teaching a fiber optic, a lens, a filter, and a polarizer. However, Crow does not cure the deficiencies of Molotov discussed above. In addition, Claims 19, 21, 30, and 32-34 depend from independent Claim 1, which is believed to be allowable as noted above. Accordingly, it is respectfully submitted that dependent Claims 19, 21, 30, and 32-34 are also allowable.

Claims 20 and 22-27 were rejected under 35 U.S.C. § 103(a) as unpatentable over Molotov in view of Sugiyama. That rejection is respectfully traversed.

The outstanding Office Action relies on Sugiyama for disclosing a mirror cavity. However, Sugiyama does not cure the deficiencies of Molotov discussed above. In addition, Claims 20 and 22-27 depend from independent Claim 1, which is believed to be allowable as noted above. Accordingly, it is respectfully submitted that dependent Claims 20 and 22-27 are also allowable.

Claims 28 and 29 were rejected under 35 U.S.C. § 103(a) as unpatentable over Molotov in view of Sugiyama and Cho.

The outstanding Office Action relies on Cho for disclosing a Bragg mirror and a mirror including a metal layer. However, Cho does not cure the deficiencies of Molotov and Sugiyama discussed above. In addition, Claims 28 and 29 depend from independent Claim 1, which is believed to be allowable as noted above. Accordingly, it is respectfully submitted that dependent Claims 28 and 29 are also allowable.

Claim 31 was rejected under 35 U.S.C. § 103(a) as unpatentable over Molotov in view of Sugiyama and Crow.

As discussed above, neither Sugiyama nor Crow cures the deficiencies of Molotov discussed above. In addition, Claim 31 depends from independent Claim 1, which is believed to be allowable as noted above. Accordingly, it is respectfully submitted that dependent Claim 31 is also allowable.

New Claims 56-65 have been added to set forth the invention in a varying scope and Applicants submit the new claims are supported by the originally filed specification. No new matter is believed to be added. In addition, Applicants respectfully submit that new Claims 56-65 are directed to Group I, Species I, elected in the previously filed response.

In particular, new Claim 56 depends from independent Claim 1 and finds support in the specification, for example at page 12, third full paragraph. Claim 56 recites that the

quantum dot of Claim 1 is encapsulated between two layers having different lattice constants than the quantum dot. Such a quantum dot is formed using a self-assembled technique in which the quantum dot is formed using a lattice ***mismatched*** layer. Molotov is silent about using such a system for fabricating a quantum dot. On the contrary, Molotov refers to a lattice ***matched*** system. Thus, Claim 56 is believed to be allowable for at least this reason.

New independent Claim 57 includes features of original Claims 1 and 10 and finds support in the specification, for example at page 12, lines 1-29. Claim 57 recites that a quantum dot is resonantly excited. Thus, a wavelength of a radiation is tuned to a desired transition wavelength of the quantum dot. The wavelength may be tuned to excite an electron in the ground state of a conduction band of the quantum dot and a hole in the ground state of the valence band of the quantum dot or the radiation may be tuned to supply electrons and/or holes into one or more of the excited energy levels of the quantum dot, as disclosed in the specification, for example at page 5, second paragraph.

Further, Claim 57 recites that the quantum dot is an encapsulated quantum dot made from a lattice mismatched system. As already discussed above, Molotov does not teach or suggest the claimed quantum dot because Molotov refers to a lattice matched system. In addition, the other references cited in the outstanding Office Action are silent about a lattice mismatched system. New Claims 58-62 depend from independent Claim 57 and are similar to Claims 5-9, respectively.

Accordingly, it is respectfully submitted that independent Claim 57 and each of the claims depending therefrom patentably distinguish over the applied art.

Independent Claim 63 includes features of original Claims 1, 5, and 11. The outstanding Office Action asserts that a modulation unit is disclosed by Frazier. However,

Frazier is directed to a transport device and not to a quantum dot as recited in Claim 63. The device of Frazier uses an applied voltage for changing a shape of a low dimensional region. In addition, Frazier does not teach or suggest using the applied voltage to vary a transition energy of a quantum dot so that the quantum dot is switched between an "on" state in which carriers can resonantly tunnel into the quantum dot and an "off" state.

Accordingly, Applicants respectfully submit that Claim 63 patentably distinguishes over the applied art.

Independent Claim 64 includes features of original Claims 1, 4, and 33. The outstanding Office Action asserts that Claim 4 is anticipated by Figure 2a of Molotov. Molotov shows in Figure 2a a complex system in which one quantum dot is coupled to another quantum dot. The output of these tunnel-coupled quantum dots produces a correlated photon pair and each member of the pair of quantum dots has a different energy. Independent Claim 64 recites a filter to select photons of a particular energy emitted from just one quantum dot. Because Molotov discloses more than one quantum dot that emits photons having two different energies and Claim 64 requires photons of a single energy to be outputted, it is respectfully submitted that the device in Molotov is different than the claimed device.

Further, a photon source that outputs single photons, necessary collects an output from a single quantum dot. Due to the small size of quantum dots, it is difficult to produce a device that includes only a single quantum dot. Molotov is silent about preparing quantum dots. However, because Molotov uses a lattice matched system, it appears that Molotov forms a quantum dot by etching a pillar.

The device of Claim 64 uses a plurality of quantum dots. The plurality of quantum dots does not produce a single photon source unless the output from a single quantum dot is

selected. By forming a plurality of quantum dots so that there is a distribution of sizes among the quantum dots, the claimed device is capable of collecting the output from just a single quantum dot. Such a photon source is not taught or disclosed in Molotov, which is directed to the formation of a single quantum dot or at most two quantum dots.

Further, Crow teaches various optical elements to achieve a specific output beam. However, Applicants respectfully submit that one of ordinary skill in the art would not select a specific optical component based on the teachings of Molotov combined with those of Crow because there is no motivation or suggestion in any of the references that it is desirable to select the output from a single quantum dot where there are a plurality of quantum dots emitting radiation.

Accordingly, Applicants respectfully submit that Claim 64 patentably distinguishes over the applied art.

Independent Claim 65 is similar to independent Claim 64, except that the plurality of quantum dots of independent Claim 65 is excited by either electrical means or optical means. When the optical means are used, an energy of an input radiation is selected such that only one of the quantum dots is excited. In other words, the input radiation is only resonant with one of the transition energies of the plurality of quantum dots. Similarly, the device may be configured in an electrical manner when electrons of a specific energy are excited into the plurality of quantum dots and only one quantum dot allows resonant tunnelling of carriers into the quantum dot, and hence output radiation.

This novel feature of selecting a single quantum dot from the plurality of quantum dots using either resonant optical excitation or electrical excitation is not taught or suggested by the applied art.

Therefore, Applicants respectfully submit that Claim 65 patentably distinguishes over the applied art.

Consequently, in light of the above discussion and in view of the present amendment, the present application is believed to be in condition for allowance and an early and favorable action to that effect is respectfully requested.

Respectfully submitted,

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